



Fermilab

\bar{p} Note #390

THIS IS A SPECIFICATION OF THE REQUIRED FREQUENCY,
RF WAVESHAPE, FREQUENCY AND TIMING REQUIRED OF
THE BUNCH COALESCING SYSTEM LOCATED IN THE MAIN RING

G.L. Nicholls

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RF WAVESHAPE, FREQUENCY AND TIMING REQUIRED OF
THE BUNCH COALESCING SYSTEM LOCATED IN THE MAIN RING.

THE ACTUAL REQUIREMENTS ARE BASED ON INFORMATION IN
SECTION 6.5 OF THE PINK TEV I DESIGN REPORT DATED 9/83

GILBERT L. NICHOLLS
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WHY COALESCE?

THE MAIN RING IS NOT CAPABLE OF ACCELERATING A LARGE
EMITTANCE (1.5 EV SEC) ANTIPROTON BUNCH AT HARMONIC NUMBER
 $H = 1113$ (53 MHZ). THERE WOULD BE EXCESSIVE PARTICLE LOSS
AT MR INJECTION ENERGY (8 GEV) AND AT TRANSITION. TO LOWER
THE EMITTANCE, THE ANTIPROTON BUNCH WILL BE SPREAD OUT AND
ACCELERATED TO 150 GEV (THE SUPERCONDUCTING MAGNET TEVITRON
INJECTION ENERGY) AS 12 OR 13 ADJACENT $H = 1113$ BUNCHES.
TO MAXIMIZE THE LUMINOSITY THE PARTICLES ARE THEN REGROUPED
INTO ONE $H = 1113$ BUNCH!

WHAT IS COALESCING?

AFTER ACCELERATION, WITH THE MAGNETS FLATTOPPED AT 150 GEV,
THE $H = 1113$ RF VOLTAGE IS REDUCED BY COUNTER PHASING. THE
COALESCING PROCEDURE IS TO ROTATE THE 12 OR 13 BUNCH
DISTRIBUTION INTO A VERTICAL STRIP CAPABLE OF BEING CONTAINED
WITHIN A SINGLE 53 MHZ ($H = 1113$) BUCKET. THE COALESCING
RF SYSTEM ($H = 53$) (2.53 MHZ) IS POWERED AND ESTABLISHES
ALL THE 12 OR 13 BUNCHES IN AN $H = 53$ BUCKET. (2.2 EV SEC.)
THE ROTATED PARTICLE DISTRIBUTION HAS A LENGTH OF 16 NSEC,
AND AN ENERGY SPREAD OF ± 100 MEV.

WHAT IS REQUIRED TO COALESCE?

AS THE PARTICLES HAVE BEEN SPREAD OUT TO MINIMIZE THE
INJECTION LOSSES, WE MUST CHOOSE A HARMONICALLY RELATED
FREQUENCY LOW ENOUGH TO CONTAIN UP TO 13 BUNCHES. WE HAVE
CHOSEN 2.53 MHZ.

TO LINEARIZE THE SYNCHROTRON MOTION AND CAPTURE ALL
THE ANTIPROTONS IN THE END BUNCHES, THE COALESCING RF
VOLTAGE IS PREFERRED NOT TO BE A SINE WAVE. IDEALLY, IT
SHOULD BE A COMBINATION OF $H = 53$ (2.53 MHZ) AND ITS
PROPERLY PHASED SECOND HARMONIC. COMPUTER SIMULATIONS
OF THE COALESCING PROCESS BY MAC LACHLAN HAVE INDICATED
THE OPTIMUM PRACTICALLY ACHIEVABLE COALESCING WAVESHAPE
IS MADE UP OF 22.8 KV OF $H = 53$ AND 4.9 KV OF ITS SECOND
HARMONIC. THIS COMBINED WAVESHAPE HAS THE POSSIBILITY OF
ROTATING ALL THE ANTIPROTONS SO THAT THEY MAY BE CAPTURED
IN A SINGLE $H = 1113$ (53 MHZ) BUCKET.

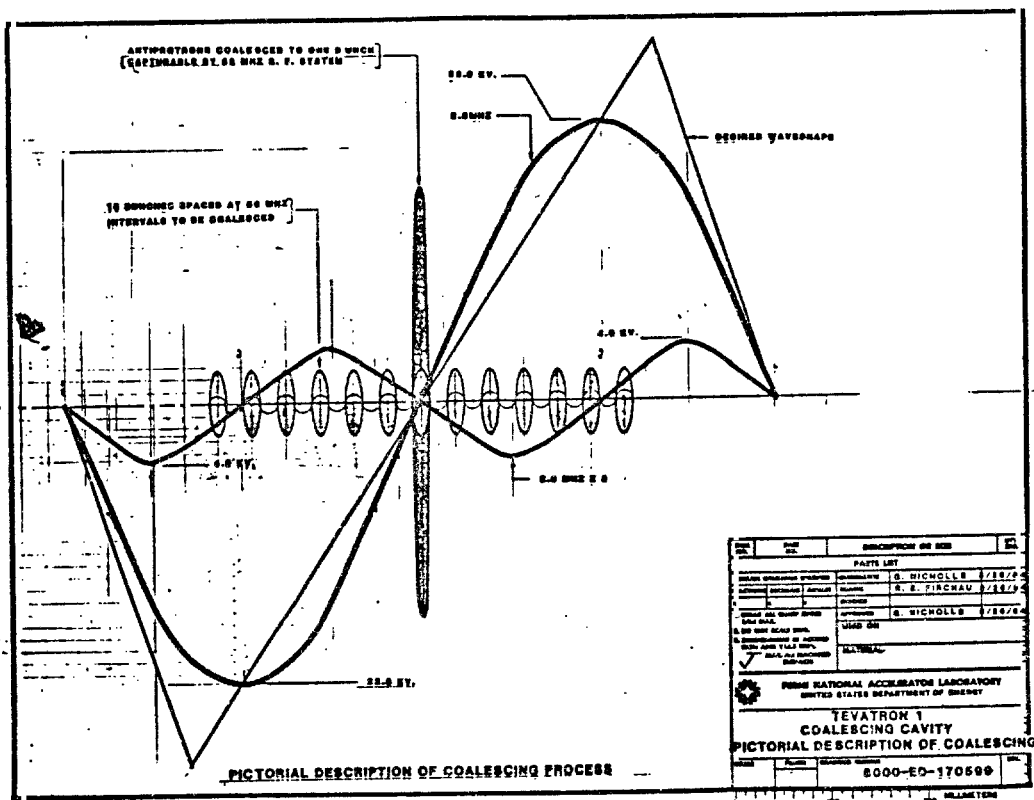


FIGURE 1 SHOWS THE COALESCING PROCESS WITH THE RF VOLTAGES WHICH MANAGE IT SUPERIMPOSED. THIS PROCESS WILL REQUIRE SLIGHTLY MORE THAN 100 MSEC. DURING BEAM STUDIES WITH PROTONS IT MAY BE REPEATED EVERY 5 TO 10 SECONDS, THUS THE SYSTEM MUST BE CAPABLE OF OPERATING AT A DUTY CYCLE OF 0.01. THE DUTY CYCLE WITH ANTIPROTONS WILL BE MUCH LOWER OR MORE CONSERVATIVE. SINCE THE ABOVE VALUES ARE THE RESULT OF SIMULATIONS, THEIR TOLERANCES MUST BE ESTABLISHED BY EXPERIMENT DURING BEAM STUDY TIME.